PATENT SPECIFICATION (11) 1 515 157

1 515 157

(21) Application No. 45057/75 (22) Filed 30 Oct. 1975

(31) Convention Application No. 2454732 (32) Filed 19 Nov. 1974 in

(33) Fed. Rep. of Germany (DE)

(44) Complete Specification Published 21 Jun. 1978

(51) INT. CL.[2] F16H 39/50

(52) Index at Acceptance
F2W 016 026 046 068 070 132 154 160 170 178 196 228 252 274 282 292 302 358 360 368 380 392 394 410 420 442 C3

(19)

(72) Inventor: Paul Bosch

(54) CONTROL DEVICE FOR HYDRAULIC PUMPS

(71) We, ROBERT BOSCH GmbH, a German company of Postfach 50, 7 Stuttgart 1, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to apparatus for controlling the outputs of at least two coupled adjustable pumps arranged to drive at least two hydraulic motors and be driven by a common driving machine, in response to the pump delivery pressures, so as to prevent overloading and stalling of the driving machine. In one such arrangement, each pump is associated with a separate output regulator having a control piston with two different effective pressure areas, means responsive to the speed of the driving machine being provided which, shortly before overload of the latter, deliver a control pulse to one of the output regulators for the purpose of reducing the delivery rate of one of the pumps.

If such apparatus is used for driving a tracked excavator or similar vehicle, then moving straight ahead is difficult when the resistances to travel of the left and right tracks are very different. It can then happen that the output regulator of the pump delivering at the higher rate resets the latter, whereupon the other pump remains at the maximal delivery rate. Consequently, the speeds of the left and right tracks are then different and the vehicle travels in a curve in an undesired manner. This situation is emphasized in a vehicle the output regulator of which is not only influenced by the pump output but also by a protection device which prevents overloading and stalling of the driving machine.

In the apparatus in accordance with the invention, an output regulator having a control piston with two different effective pressure areas is provided for each pump and means responsive to the speed of the driving machine are provided for delivering control signals to the output regulators for the purpose of reducing the output of one of the pumps, the apparatus also comprising an electronic control device, sensors, each responsive to the adjustment of one of the pumps and each providing an input to the electronic control device, control valves, each arranged to deliver the output from one of the pumps to one of the hydraulic motors, further sensors, each responsive to the setting of one of the control valves and each providing a further input to the electronic control device, magnetic valves, each responsive to an output from the electronic control device and each controlling the operation of one of the output regulators in such a manner that the pumps are so adjusted with respect to the settings of the control valves that working fluid is delivered to each of the hydraulic motors at a respective uniform rate.

Apparatus in accordance with the invention can be used to control the pumps of an hydrostatic double track caterpillar drive so that it is possible to travel straight ahead accurately. With a modified form of apparatus, it is also possible to so operate auxiliary devices, for example excavating shovels, that working fluid and power losses are completely avoided.

With the aid of an additional device for the control of an excavator shovel, it is possible to adjust the delivery rate of the pumps in accordance with the displacement of each control valve required for that purpose so that the pumps only delivery at the particular rate required whereby working fluid losses and power losses are avoided.

In order that the invention may be clearly understood and readily carried into effect, two embodiments thereof will now be described with reference to the accompanying drawings in which

Figure 1 is a diagrammatic representation of an apparatus for controlling two adjustable pumps,

Figure 2 is a diagrammatic representation of

a modification of the embodiment according to Figure 1 and

Figure 3 is a detail of the embodiment of Figure 2.

In Figure 1, two adjustable radial piston pumps are represented by 10 and 11 in a simplified manner. Each pump has a rotor 12 or 13 and a stroke ring 14 or 15 serving as an adjustment member eccentrically displaceable with respect to the respective rotor 12 or 13. In the rotors there are arranged pistons (not shown) which slide on the inner surfaces of the stroke rings. An output regulator 16 is associated with the pump 11 and an output regulator 17 is associated with the pump 12. These output regulators 16 and 17 control the degree of eccentricity of the stroke rings 14 and 15 and thus control the outputs or delivery rates of the pumps 10 and 11.

The stroke rings 14 cooperates with an electrical sensor 18 which feeds, through an electrical conductor 19, the position of the stroke ring 14 as an input to an electronic control apparatus 20. An electrical sensor 21 cooperates with the stroke ring 15 and likewise feeds, through an electric conductor 22, the position of the stroke ring 15 as another input to the electronic control apparatus 20. Furthermore, the speed of the common pump shaft 10' is fed to the electronic control apparatus 20 through means comprising a speed transmitter 54.

An electrical conductor 23 leads from the electronic control apparatus 20 to an electromagnetic valve 24 which is associated with the output regulator 17. Furthermore, an electrical conductor 25 leads from the electronic control apparatus 20 to an electromagnetic valve 26.

The two output lines 27 and 28 from the pumps 10 and 11 are connected to one another by a line 29 in which is arranged a shuttle valve 30. Lines 31 and 32 from this shuttle valve lead through the electromagnetic valves 24 and 26 to the output regulators 16 and 17. From the latter, lines 33 and 34 lead to the lines 27 and 28. The delivery pressures of the pumps 10 and 11 always prevail in the respective lines 33 and 34. The output regulators 16 and 17 are also controlled from the high pressure side according to the position of the electromagnetic valves 24 and 26, that is to say open or closed. If due to the load on the driving machine, its speed falls below the predetermined desired speed, then one or both magnetic valves 24 and 26 are so controlled by the speed transmitter 54 and the electronic control apparatus 20 that the output of one or each of the pumps is reset so that overloading of the driving machine and a further drop in the speed are prevented.

Furthermore, two control valves 38 and 39 which are formed as slide valves are provided in the apparatus. The valve 38 is operated with the aid of a lever 40, the valve 39 with the aid of a lever 41. The valve 38 is in communication through a line 42 with the line 28 and the valve 39 is in communication with the line 27 through a line 43. From the control valve 38, a line 44 leads to an hydraulic motor 45 and from the control valve 39 a line 46 leads to an hydraulic motor 47. The hydraulic motors 45 and 47 serve for driving the tracks of an excavator.

The control valve 38 has a slide valve member 48 the position of which is fed as an input to the electronic control apparatus 20 by a further sensor 49. The control valve 39 has a slide valve member 50 the position of which is likewise fed as another input into the electronic control apparatus 20 through a further sensor 51.

Thus, the control unit 20 must contain means arranged to compare the settings of the stroke rings 14 and 15 signalled by the sensors 18 and 21, with the settings commanded by the adjustment of the control valves 38 and 39 signalled by the further sensors 49 and 51. It must also include means arranged to provide control signals to the magnetic valves 24 and 26 such as to ensure correspondence between the desired and actual stroke ring settings.

Furthermore, the control unit 20 must include means responsive to any variation, from a pre-set speed, in the speed of the pump shaft 10' signalled by the speed transmitter 54 and which modify the control signals applied to the magnetic valves 24 and 26 as may be necessary to prevent any drop in speed below a predetermined speed.

The design of both these means is well within the capacity of any skilled electronics engineer.

For driving the excavator, the driver operates the control valves 38 and 39, which control the supply of working fluid from the pumps 10 and 11 to the hydraulic motors 45 and 47, with the aid of the control levers 40 and 41. The displacements of the valve members 48 and 50 are compared in the electronic control apparatus 20 with the positions of the stroke rings 14 and 15 of the pumps 10 and 11. If straight line travel is required and the settings of the stroke rings 14 and 15 do not conform to the displacements of the valve members 48 and 50, then the electronic control apparatus 20 so controls the stroke rings 14 and 15, through the electro-magnetic valves 24 and 26, that the displacements of the valve members and the stroke ring eccentricities match and working fluid is still delivered to the hydraulic motors at a respective uniform rate. Thus, the latter are so controlled that the vehicle travels in a straight line when both control valves are displaced to the same extent and indeed even when the overload protection has reset the pumps to a smaller delivery rate. Due to the control of the output regulators by the electromagnetic valves 24 and 26, adjusting cylinders 52 and 53 for the stroke rings 14 and 15, so adjust the pumps 10 and 11 that they deliver respective amounts of working fluid to the motors, required for accurate straight line

travel. If the valve members of the control valves 38 and 39 are set differently, then the stroke rings 14 and 15 will also be controlled to correspondingly different eccentricities and the vehicle will travel over a curve, working fluid being delivered to the hydraulic motors at a respective uniform rate in accordance with the settings of the valves 38 and 39.

The embodiment according to Figure 2 differs from that according to Figure 1 in that the control for the excavator shovel is also represented therein. This takes place with the aid of two control devices 60 and 61 which are of similar construction. Levers 62 and 63 of the devices are mounted in ball joints 62', 63' fixed to the frame and are guided at a distance therefrom in guide slots 64, 65 or 66, 67 extending respectively at right angles to one another. Further control valves 70 and 71 are adjusted by the guides 64 and 65 and further control valves 72 and 73 are adjusted by the guides 66 and 67. The movements of hydraulic actuators, such as the one referenced with 74, for the jib, the arm, the bucket and the rotary mechanism of the excavator, are controlled by the valves 70 to 73.

A displacement sensor 75 is linked to the control lever 62 and a displacement sensor 76 is linked to the control lever 63. The control signals from these sensors are also fed to the electronic control apparatus 20. The output signals from the sensors 75 and 76 are compared in the electronic control apparatus 20 with the actual valve signals from the sensors 18 and 21, corresponding to the setting of the stroke rings of the pumps 10 and 11. Then, in accordance with a corresponding increase in the difference between the signals, the electronic apparatus controls the two pumps through the two magnetic valves 24 and 26 and the controlled output regulators 16 and 17 so that the two pumps 10 and 11 deliver no more pressure medium than is required for the hydraulic actuators, that is to say, in accordance with the position of the control levers 62 and 63. From this it can be appreciated that the outputs from the pumps can be adjusted with this additional control, in accordance with the displacement of the control valves 70 to 73 actuated at the time. In this manner, working fluid losses and load losses are avoided.

WHAT WE CLAIM IS:

1. Apparatus for controlling the outputs of at least two coupled adjustable pumps arranged to drive at least two hydraulic motors and be driven by a common driving machine, in response to the pump delivery pressures, so as to prevent over-loading and stalling of the driving machine, in which output regulator having a control piston with two different effective pressure areas is provided for each pump and means responsive to the speed of the driving machine are provided for delivering control signals to the output regulators for the purpose of reducing the output of one of the pumps, the apparatus also comprising an electronic control device, sensors, each responsive to the adjustment of one of the pumps and each providing an input to the electronic control device, control valves, each arranged to deliver the output from one of the pumps to one of the hydraulic motors, further sensors, each responsive to the setting of one of the control valves and each providing a further input to the electronic control device, magnetic valves, each responsive to an output from the electronic control device and each controlling the operation of one of the output regulators in such a manner that the pumps are so adjusted with respect to the settings of the control valves that working fluid is delivered to each of the hydraulic motors at a respective uniform rate.

2. Apparatus according to claim 1, in which the hydraulic motors are arranged to drive the tracks or wheels of a vehicle.

3. Apparatus according to claim 1 or claim 2, in which the pumps are radial piston pumps having eccentrically adjustable stroke rings each of which engages a sensor responsive to adjustment of the pump.

4. Apparatus according to any one of claims 1 to 3, in which the control valves are slide valves, the valve members of which each cooperate with a displacement sensor.

5. Apparatus according to any one of claims 1 to 4 in which, in addition to the two control valves, further optionally actuable control valves, each provided with a control lever, are provided for the control of working fluid to further loads, a displacement sensor being associated with each control lever, and the signals from the sensors being fed to the electronic control apparatus and being compared therein with the inputs derived from the pump adjustment sensors.

6. Apparatus for controlling the outputs of at least two coupled adjustable pumps, substantially as herein described with reference to Figure 1 or Figures 2 and 3 of the accompanying drawings.

A.A. THORNTON & CO.,
Chartered Patent Agents,
Northumberland House,
303/306 High Holborn,
London, WC1.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1978.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.

1515157 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig. 1

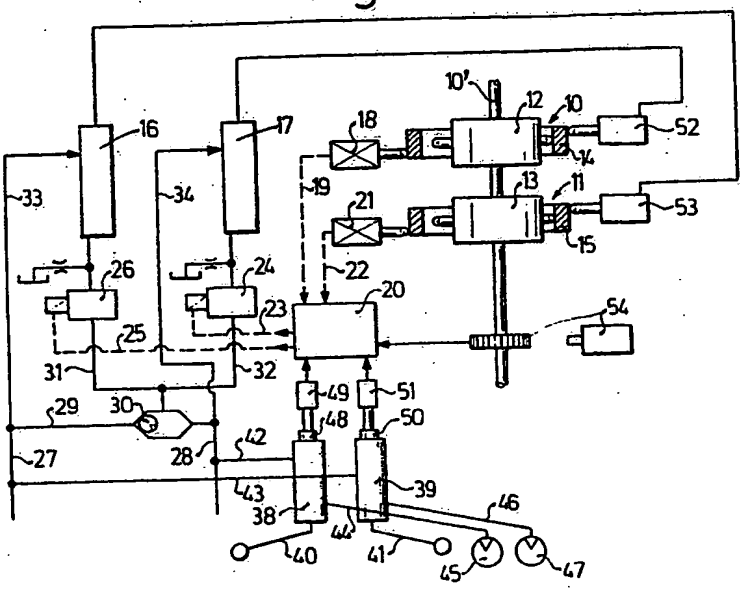

Fig. 2

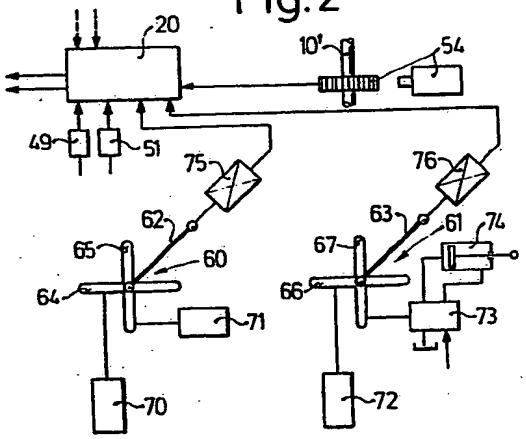

Fig. 3